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## **ENHANCED RADIO SYSTEMS AND METHODS**

By

Caron S. Ellis

And

Michael D. Ellis

10 **CROSS REFERENCE TO RELATED APPLICATION**

This is a continuation application of International Application No. PCT/US02/05039 filed February 20, 2002 which claims the benefit of United States Provisional Patent Application No. 60/270,463, filed February 20, 2001, which is hereby incorporated by reference herein in its entirety.

15 **FIELD OF INVENTION**

Our invention relates to radio systems and methods. In particular this invention relates to enhanced radio reception and processing features, utilizing multiple radio receivers, digital storage of radio content, independent control of radio reception and playback, listener profiles, and two-way communication features.

20 **BACKGROUND OF THE INVENTION**

Radio is a very popular entertainment source today. It is used in many locations – in the home, in the automobile, at the office, and on the go. Sources available today

include broadcast (AM and FM), Internet, and satellite. However, radio functions have been fairly constant for years.

New technologies have become available in recent years. These include less expensive tuners, less expensive memory, and better quality analog to digital conversion.  
5 These technologies make possible an enhanced radio system.

Some improvements have been made in television systems recently. Personal video recorders, such as those manufactured by TiVo, allow a user to easily record a television program, and also provide VCR-like controls for television programs. For example, see U.S. Patent No. 6,259,441 (2001) to Ahmad et al., "Display pause with  
10 elastic playback," U.S. Patent No. 6,327,418 (2001) to Barton, "Method and apparatus implementing random access and time-based functions on a continuous stream of formatted digital data," and U.S. Patent No. 6,233,389 (2001) to Barton et al., "Multimedia time warping system". However, these types of improvements have been optimized for the needs of the television viewer. For instance, this prior art focuses on  
15 improving the viewing of specific television programs.

Radio listeners typically have different needs than television viewers. For example, television viewing typically happens in a fixed environment in a home, while radio listening often happens in varied, often mobile, environments. People may listen to the radio in a shower. People often listen to radio in a car, or carry a radio on their person  
20 as they pursue other activities. A television viewer may sit and watch a program through its completion. A radio listener more often listens casually while pursuing other activities, and may often switch between stations based on hearing a short duration item, such as a song, commercial, or traffic/weather report. Program schedules are quite important to television viewers, but are rarely used by radio listeners.

25 A system is needed that allows a radio listener to better control the audio content she hears. For example, a listener may need a way to easily back up and hear something again. This might include, for example, repeating a piece of information from a weather report or a traffic report, a phone number or other item in an advertisement, a favorite song, or information about a radio contest.

A radio listener may also need a way to pause the radio content while doing something else. For example, a listener in a car may wish to pause a song while concentrating on traffic or talking to someone else in the car. After resuming the song, the listener may listen to the remainder of the song and then may subsequently wish to fast-forward through commercials to catch up to the real-time broadcast.

U.S. Patent No. 5,345,430 (1994) to Moe, "Recovery recorder system, particularly commercial radio/TV broadcast recovery recorder system," discloses continuously recording the last few minutes of a program being monitored to a short-term memory, and transferring it, on operator command, to a long-term storage media. U.S. Patent No. 5,448,534 (1995) to Okada, "Radio with recording and reproducing function," discloses detecting a desired program and starting a recording device to record the program. However, this prior art requires a user to select a specific radio station or program to record.

Because digitized audio content requires much less memory than digitized video content, it is less expensive to store a significant amount of radio content. A radio tuner is also less costly than a television tuner, so a system that monitors multiple radio stations at once is quite feasible. Because a radio listener is quite likely to be interested in the programming on multiple radio stations at the same time, a system with multiple tuners and significant but inexpensive memory is also quite useful.

For example, a system is needed that would allow a user to switch between multiple favorite radio stations and rewind to the start of an interesting piece of content that may have been missed, such as a favorite song or a traffic report. Because detailed radio content schedules are not typically published in advance, it would also be useful to have a system that allows a user to identify items of interest, that informs the user when an item of interest is being broadcast on another station, and that allows the user to switch to that station and rewind back to the start of the item.

Since radio listeners frequently sing along with favorite tunes in locations such as the shower and the car, a user may wish to sing along with a radio in a karaoke mode.

A system is also needed to recommend a set of radio stations to a user. This would be particularly useful for traveling users, or users new to an area. Such a system might allow a radio listener in a rental car or hotel to automatically search a database of radio stations and find one or more that matches his tastes. A driver on a long trip may  
5 need a system that automatically monitors available radio stations and compares the content with his likes.

Traveling listeners may also need a system to inform them of venues and events in an unfamiliar local area. For example, a listener may be interested in finding out about concerts, celebrity appearances, radio station events, concert venues, music stores, and  
10 the like.

Radio listeners often listen in multiple environments – in different rooms of the house, in the car, in the office, and using a portable system. These listeners need a system that allows them to use the advanced radio features in all of these environments. They need a way to transfer information, such as radio presets, favorite songs, and  
15 favorite artists, from one environment to another. They need a way to update the functionality of the radio without having to purchase a new system. They need a system that allows downloading of favorite songs into a radio.

Radio listeners also need an Internet environment to coordinate their enhanced radio listening activities. These activities might include finding out about music,  
20 shopping for music related products, and finding out about radio stations. They may also need a system that allows them to manage the information used in an enhanced radio system, such as favorite stations, artists, and songs.

A radio listener may also need a way to more easily respond to radio content. For example, a listener may wish to respond to an ad, enter a radio contest, call in to a radio  
25 talk show, or make a song request. The user may need a system that allows a telephone to be used with the radio system.

A radio listener also needs a way to more easily communicate with other radio listeners. A listener may wish to send information heard on the radio to another person. This information may include an invitation to or information about a concert or other

event, a link to a radio station or radio show, a song heard on the radio, or other radio-related information.

In addition to radio listeners, radio service providers may also benefit from our invention. Radio service providers need a system that allows them to monitor the habits  
5 of their listeners' demographic profile such as which commercials they repeat, which artists they favor, etc., as well as what enhanced radio features their users may access.

## SUMMARY

These and other advantages are provided by our enhanced radio system. A main aspect of our invention is simultaneously storing the content from multiple radio  
10 receivers. Another aspect of our invention is allowing the multiple receivers to be tuned to radio stations based on stations chosen as favorites by the listener, based on recently played stations, and based on scanning for new stations. Another aspect of our invention is allowing a listener to quickly select output from the stored content of any of the receivers. A further aspect is allowing a listener to pause, resume, or skip backwards or  
15 forwards in time within any of the stored content, including allowing a listener to hear radio content broadcast prior to switching to a station. Another aspect of our invention is allowing a listener to record radio content, or download other audio content, and quickly access it later. Yet another aspect of our invention relates to providing a karaoke feature, with the removal of vocal tracks and the display of lyrics for broadcast songs.

20 Other aspects of our invention relate to the collection and use of user preferences. A listener may be allowed to rate specific content or groups of content. The system may recognize and notify the listener of preferred content when it is broadcast on a station that the listener is not currently listening to. The system may recognize and automatically skip over disliked content when it is played on a station the user is listening to. The  
25 system may recommend radio stations to a listener. The system may recommend local events and facilities to a listener.

Still further aspects of our invention relate to communications. Our invention may interact with a mobile or stationary telephone, using the radio's sound system, and

may automatically pause or mute the radio during calls. Our invention may allow a listener to send and receive messages with another listener, including recorded radio content. Our invention may allow a listener to easily respond to radio content, such as contests, requests, call-in shows, pledge drives, etc. A listener can purchase CDs, concert tickets, and other products and services. Our invention may include an Internet website, with additional radio features. And our invention may provide monitoring of listener usage and habits to provide a ratings service.

Other aspects of our invention relate to portability and configurability. Our enhanced radio system may be used at home, at the office, in the shower, on the go, in the car, on the boat, or in any other environment. It may be used in multiple environments. And user preferences and profiles may follow the listener in any of these environments, from radio to radio.

This system can tune in one or more radio sources, such as broadcast radio, satellite radio, Internet radio, short-wave radio, and radio scanners. The system may employ multiple receivers (e.g., antennas, tuners, etc.), so that the system can monitor multiple radio stations at the same time. If any of the input signals is analog, it is digitized, and then the digital radio signal is stored in memory.

Our invention also includes a controller, such as a microprocessor with program memory, to control the functions of the receivers, digitizers, and other parts of the system. A user can control the functions of the controller using an input device such as a remote control, a voice control, a front panel control, etc. There may also be a display to provide visual feedback to the user.

Digital audio signals are retrieved from the memory on command from the user, converted to analog signals, and sent to an output device, which may include an amplifier, speakers, and the like.

Our enhanced radio system may be operated in a home or office, in a shower, in a car, truck or boat, or as a portable system carried or worn by the user. The system may also be configurable so that it can operate in multiple environments by, for example, allowing the user to use different input controls and different audio output devices.



Our invention may provide a number of features beyond what are provided by standard radios today. For example, the system may allow the user to stop, rewind, fast-forward, and resume playing the radio, while continuing to record the radio input. For example, the user may rewind to replay a segment of interest, and then fast-forward to  
5 continue playing the broadcast audio.

The system may allow the user to skip-back or forward a preset interval, such as 30 seconds. This may allow, for example, the user to skip over commercials in recorded audio.

The system may provide different speed playing. When playing at reduced or  
10 increased speeds, it may provide frequency compensation so that the sound is recognizable.

Our invention may allow the user to record a portion of the radio input in memory for later playback. Recording may be based on impulse/command, based on a published schedule of radio content, based on a specific time/station, or on other criteria.  
15 Recordings may also be stored or transferred to an external analog or digital storage device.

The system may provide preset stations. Stored radio programs may be available as preset stations separate from the stations from which they were recorded.

This invention may allow identification of specific pieces of audio content, such  
20 as songs and commercials. The system may allow the user to indicate (e.g., by pressing a button or other control) that a piece of content has begun or ended. The system may also recognize the start or end of content based on silence, changes in audio characteristics, or other cues in the audio. For example, the system may measure the frequency and power content of the audio signal, and recognize new content based on changes in harmonic  
25 content, rhythmic content, etc.

The system may recognize a piece of content that has previously been identified. The user may be allowed, for example, to name a piece of content, and to identify the type of content (song, commercial, talk, etc.) The system may create a unique signature of the audio signal of a particular piece of content, and use that signature to recognize

that content on future occasions. Signatures may be created separately in an external system and downloaded from the external system into the enhanced radio system. Also, information sent either in-band with the audio or in a separate channel (e.g., over the Internet) may identify the content currently being broadcast. The system may include a  
5 separate receiver to receive the separate information signal.

The system may allow the user to rate a piece of content. For example, the user may be able to specify a like or dislike for a particular song or commercial, or to indicate a level of interest. The user may also to be able to rate a specific musical artist, station, radio show, and other sets of content. The system may be configured to skip over  
10 undesirable content.

Our invention may include multiple radio inputs. The radio signals from each input may be simultaneously digitized and recorded. For example, the user may be allowed five favorite stations in a system with six tuners. In this way the system may always be recording the favorite stations and the most recently tuned station in addition to  
15 whatever station the user is currently listening to. The user may tune to any of the favorite stations at any time, and be able to rewind to content that may have been otherwise missed. For example, the user could tune to a station in the middle of a song and immediately rewind to the beginning of the song, as the audio from the song has previously been digitized and stored to memory. Similarly, the user could rewind to hear  
20 a traffic or weather report that was missed, clues and phone number for a radio contest, details in an ad of interest, or any other content of interest. Our invention may also provide a scan feature, briefly playing audio from the available radio stations in sequence, allowing the user to stop when something of interest is heard, and allowing the user to skip-back to the start of the item of interest.

25 The system may provide an alert when content of interest is being played on a different station. For example, when a favorite song or artist is played on a station other than the current station, the system may notify the user, who could tune to that station and rewind to the beginning of the song. The system may provide a single button to tune to the station with the most recent content of interest notification. Alternatively, the system



may automatically change to the station with the content of interest, and may automatically rewind to the start of the content.

The system may compare information about the user's likes and dislikes with information about radio stations to create recommendations. The user may enter  
5 information about her likes and dislikes, or this information may be obtained automatically by monitoring the content she listens to. For example, a recommendation may be provided in any of the following ways: there may be a list of stations that the user can choose from; the system may automatically set one or more presets based on the recommendations; or the system may automatically tune to the recommended stations.

10 Our invention may obtain information about stations in a number of ways. For example, the information may be sent in-band with the radio signal or delivered concurrently but over a separate communications channel. Information may be downloaded into the system from a database of station characteristics using, for example, a wireless Internet connection. Such a database may include, for example, stations,  
15 format, geographical reach, program schedules, etc. The system may monitor the content of the prospective station and compare its content with the signatures of the content the user has rated.

Radio recommendations might be especially useful to a traveling user who is not familiar with local stations. For example, these features may be built into a portable  
20 enhanced radio system. A rental car radio may be equipped with an enhanced radio system including these features. A user may insert a smart card or other device into the radio to indicate preferences, and the system may automatically determine the best matching local stations. Such a system may, for example, set the presets, automatically tune, record, or otherwise make the recommended content available to the user. The  
25 system may include a global positioning system (GPS) unit to determine the user's current location as an index into a database of radio stations, and then scan the database for stations matching the user's criteria. The system may alternatively scan radio stations using a tuner other than the one the user is currently listening to, and compare the content on each station with signatures indicating the user's preferences.

The system may provide automatic notification of local concerts, performing artist appearances, signings, radio station events, weather, and other events of interest. This information may be of interest to all types of users, including those users who are traveling in an unfamiliar region. Similarly, the system may provide information about  
5 local music venues, stores, and other facilities and businesses.

Our invention may include a communications device, such as a radio frequency transceiver, modem, portable memory device, or networking equipment. This device may be used to allow the system to download a user's profile, download radio station data, and synchronize information between a user's different enhanced radio systems in  
10 different locations. The device may be used to update the software in the enhanced radio system, to download songs into the enhanced radio system, and to report usage information to a ratings service. The system may, for example, use the user's telephone or mobile phone as a link to access remote data.

The user may have multiple enhanced radio systems, to be used in different  
15 environments. All of the user's various enhanced radio systems may be synchronized. For example, likes, dislikes, and presets may be exchanged between the systems. Synchronization may be Internet based, for example, by allowing the user to upload data from an enhanced radio system to a web site, and to download data from the web site to another enhanced radio system.

20 The user may access an enhanced radio web site using a web browser. The web site may provide features such as a shopping for CDs and other products, concert information and ticket buying, trivia questions, contests, music information databases, etc. The web site may provide a computer desktop radio feature, allowing the user to listen to radio on a personal computer while connected to the Internet. The Internet  
25 website may also have advertisements, which may be based on user preferences, either as determined by the web site, or as uploaded from an enhanced radio system.

The web site may also include access to radio station databases and schedules, which may be downloaded to an enhanced radio system. Data may be loaded into a mobile phone or personal digital assistant, which may be used to load information into an  
30 enhanced radio system in, for example, a rental car. Data may include such information

as station names and frequencies, formats, play lists, signatures, schedules, geographical reach, etc.

A two-way communication feature may be included as part of an enhanced radio system and may provide a number of advantages. For example, the user may be able to  
5 respond directly to radio advertisements without having to telephone, or the system may auto-dial a mobile telephone to a phone number included in the advertisement. Similarly, the user may respond to contests and call-in shows, and make requests, either directly using the two-way communication feature, or the system may auto-dial the radio station to support these features. The auto-dialed phone number may be hand-entered by the  
10 user, part of the radio station database, or included in information sent as part of or separately from the radio signal. In addition, the user may buy CDs, buy concert tickets, participate in live chats, and other features. The user may select these features using a voice command or other types of controls.

The system may also incorporate telephone functions. The system may connect  
15 with a mobile telephone or a wired telephone service. The system may provide telephone audio using the enhanced radio's voice input and audio output. The system may automatically pause or mute the radio audio while a call is in progress.

The system may allow one enhanced radio user to send an instant message or other electronic message to another enhanced radio user. The message may, for example,  
20 be text, voice, or a combination. The message may include all or part of content from a radio station, such as a song. The message may be otherwise related to radio content, for example including a link allowing the recipient to easily tune to a specific station or show. It may include, for example, a signature of a specific song. The message may be, for example, an invitation to a concert or other event.

25 The system may also provide a karaoke mode. In this mode, it may remove the vocal component from the audio signal as it is being played. It may also display lyrics of a song as it is being played.

Information may be loaded into an enhanced radio system by any number of methods. For example, information may be received (and sent) over a wireless link, such

as a wireless telephone or paging link. Information may be loaded via prerecorded media, such as a compact disk or digital versatile disk. Information may be loaded from a smart card, PC Card, or other portable memory device. Information may be received and sent via a telephone link. Information may be exchanged over the Internet.

- 5 Information may be entered by hand.

## BRIEF DESCRIPTION OF THE DRAWINGS

Further features of our invention, its nature and various advantages will become more apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to  
5 like parts throughout, and in which:

FIG. 1 is an illustrative block diagram of one embodiment of the enhanced radio system of the present invention;

FIG. 2 is an illustrative block diagram of the controller of FIG. 1;

FIG. 3A is an illustrative block diagram of radio sources of FIG. 1;

10 FIG. 3B and FIG. 3C are further illustrative block diagrams of alternative embodiments of a portion of FIG. 1;

FIG. 4 is an illustrative block diagram of the communications device of FIG. 1;

FIG. 5A and FIG. 5B are illustrative flow charts of one embodiment of the enhanced radio method of the present invention;

15 FIGs. 6A through 6D are illustrations of various embodiments of the enhanced radio system of the present invention;

FIG. 7 is an illustrative flow chart showing configuration steps of the enhanced radio method of the present invention;

20 FIG. 8 is an illustrative flow chart showing additional configuration steps of the enhanced radio method of the present invention;

FIG. 9 is an illustrative flow chart showing audio control steps of the enhanced radio method of the present invention;

FIG. 10A and FIG. 10B are illustrative flow charts showing steps relating to recording of radio content using the present invention;

25 FIG. 11 is an illustrative flow chart showing steps related to allowing audio content to be downloaded into the enhanced radio system of the present invention;

FIG. 12 shows an illustrative display screen that may be used for recording radio content in the enhanced radio system of the present invention;

FIG. 13 is an illustrative flow chart showing steps related to selecting favorite radio stations in the present invention;

5        FIG. 14 and FIG. 15 are illustrative flow charts showing steps related to identifying an item of radio content in the enhanced radio system of the present invention;

FIG. 16 is an illustrative data structure that may be used in the identification of an item of radio content in the enhanced radio system of the present invention;

10        FIGs. 17A through 17C are illustrative graphs of data that may be used to identify items of radio content in the enhanced radio system of the present invention;

FIG. 18 and FIG. 19 are illustrative flow charts showing steps related to grouping items of radio content in the enhanced radio system of the present invention;

15        FIG. 20 is an illustrative display screen that may be used in the rating of groups of radio content in the enhanced radio system of the present invention;

FIG. 21 through FIG. 24 are illustrative flow charts showing steps related to recommending radio stations in the enhanced radio system of the present invention;

FIG. 25 and FIG. 26 are illustrative data structures that may be use in the enhanced radio system of the present invention;

20        FIG. 27 is an illustrative display screen that may be used in the recommending of radio stations in the enhanced radio system of the present invention;

FIG. 28A and FIG. 28B are illustrative flow charts showing steps related to recommending local events and facilities in the enhanced radio system of the present invention;

25        FIG. 29A and FIG. 29B are illustrative display screens that may be used in the recommending of local events in the enhanced radio system of the present invention;



FIG. 30 is an illustrative flow chart showing steps related to communication features in the enhanced radio system of the present invention;

FIG. 31 is an illustrative display screen that may be used in an enhanced radio web site in the enhanced radio system of the present invention;

5        FIG. 32A and FIG. 32B are illustrative block diagrams showing how a portable device may be used with a computer and the enhanced radio system of the present invention for downloading data;

FIGs. 33A through 33C are illustrative display screens that may be used in a radio response feature in the enhanced radio system of the present invention;

10       FIG. 34 is an illustrative flow chart showing steps related to providing a radio response feature in the enhanced radio system of the present invention;

FIG. 35 is an illustrative flow chart showing steps related to providing a user message feature in the enhanced radio system of the present invention;

15       FIGs. 36A through 36F show illustrative display screens that may be used in providing a user message feature in the enhanced radio system of the present invention;

FIG. 37 is an illustrative flow chart showing steps for reporting radio usage data in the enhanced radio system of the present invention;

FIG. 38 is an illustrative flow chart showing steps for providing a karaoke mode in the enhanced radio system of the present invention;

20       FIG. 39 is an illustrative flow chart showing steps for integrating radio and telephone functions in the enhanced radio system of the present invention;

FIG. 40 is an illustrative flow chart showing steps for providing a scan feature in the enhanced radio system of the present invention;

25       FIG. 41 is an illustrative memory map for one embodiment of the enhanced radio system of the present invention; and

FIG. 42 is an overview of the features of our invention.

## DETAILED DESCRIPTION

Our invention is such an enhanced radio system. As described above, it provides many functions not available in radios today. An overview of out invention is shown in FIG. 42.

5           Radio listener **4202** may have access to many new features. Multiple radio stations **4204** from one or more radio sources may be available. Multiple receivers **4206** may simultaneously receive the multiple radio stations **4204**, and store them digitally into buffers **4208** in computer digital storage device **4209**, storing the most recent several minutes of each. One of the buffers may be used to provide an audio output **4210** for the  
10 listener **4202**. The listener may choose a subset of the available radio stations **4204** and assign them to presets **4216**, and the system will continuously monitor those favorite stations, storing recent content from each into buffers **4206**. The system may continuously monitor the most recently listened station or stations **4215**, storing recent content from each into buffers **4206**. And the system may allow the listener to scan  
15 through all available stations, while tuning ahead to each before it is played for the listener, and storing its content into the one of the buffers **4206**. The listener can use audio controls **4212** on the audio from any station as it is played. The listener may pause and resume play. The listener can skip back to earlier content, even content that was broadcast prior to when the user started listening to the station. And the listener can skip  
20 forward over content that is not of interest.

The listener may record songs **4218** and other content from the radio and replay them later, or download songs from other sources. The listener can rate songs **4248**. At a later time, the system may use the listener ratings to act on songs and other content that are broadcast. If a song that the listener likes **4246** is broadcast on a station that the user  
25 is not listening, the system may notify the user or automatically switch to the song, and the listener can hear the song from the beginning. If a song that the listener does not like **4247** is broadcast, the system may automatically skip over it. The system may provide a karaoke mode **4240**, allowing the listener to sing along with a song.

The system may interface with a telephone **4244**. The telephone **4244** may use the radio's speakers and microphone. The radio broadcast may be automatically muted or paused when a call is in progress. The listener can send messages **4242** to other listeners and receive messages from other listeners, and the messages **4242** may include text,  
 5 voice, and content recorded from the radio. The listener can respond to radio content, such as contests **4224**, commercials, call-in shows, pledge drives, and other radio content. When traveling **4220**, the system may recommend radio station, local events, and local facilities. The listener may be able to access features of this invention on the Internet **4226**, including setting preferences, and downloading a listener profile.

10 The enhanced radio system may be accessed in any location where the listener wishes to listen to radio. This may include at home **4228**, at the office **4230**, in the shower **4232**, on the go **4234**, in the car **4236**, or in the boat **4238**. Listener preferences and profiles may follow the listener wherever he goes. Listener actions may be reported to a radio rating service **4222**, to collect information on what radio content and features  
 15 are most popular.

Turning to FIG. 1, an embodiment **10** of our enhanced radio system (ERS) invention is shown. One or more radio sources **100** may be supported. These sources may be broadcast radio, satellite radio, Internet radio, or other such sources. A radio receiver **110** is provided to receive the input signals from each source. This may be, for  
 20 example, an antenna and a tuner. It may also be equipment to receive audio data from the Internet, and may include a telephone, wireless, or cable modem, a computer, and software. Multiple radio receivers may be provided for a single radio source. For example, the system may include one antenna and several tuners.

One or more digitizers **115** may be provided for each analog input. These  
 25 digitizers convert the received analog audio signal into a stream of digital data that can be stored in a memory device **120**. A digitizer is not required for digital audio sources, such as Internet and digital satellite radio. Multiple radio receivers may share a single digitizer. The output of the digitizer **115**, or the output of digital radio receivers **110**, may be stored in memory **120**. Memory **120** may be any suitable memory device, such as

random access memory, static memory, disk drive, or other suitable electronic, magnetic, optical or other storage device.

The functions of the radio receivers **110** and digitizers **115** may be controlled by a controller **145**. The controller **145** may have memory to store software and a processor to run software. The controller **145** may receive user commands from user controls **140** and display information for the user on optional display device **150**. In embodiments in which the radio receiver **110** has a processor, such as to receive Internet radio, controller **145**, user controls **140**, and display device **150** may be included with radio receiver **110**.

The user may also direct controller **145**, using user controls **140**, to send digital audio data from memory **120** to digital-to-analog converter **125**, and to send audio signals from digital-to-analog converter **125** to audio output **130**. Audio output **130** may include, for example, amplifiers, speakers, headphones, and the like. User controls **140** may include buttons, knobs, a remote control, a voice input device, or any combination of these and other types of inputs.

The system may also include optional communications device **155**. This may include, for example, a modem (e.g., wireless, telephone, cable, digital subscriber line (DSL), etc.), a wireless transceiver such as a paging transceiver, computer networking equipment (e.g., a router, a hub, an Ethernet transceiver, etc.), a portable memory device (e.g., a flash memory card, a smart card, a personal digital assistant (PDA), etc.), or other communications devices. Controller **145** may send and receive information from one or more external systems using communications device **155**, and store this information in local memory, such as memory within controller **145**.

The system may include optional global positioning system device **160**. This device may determine the geographic location of the enhanced radio system using the global positioning system satellites, and send that information to controller **145**.

FIG. 2 shows an illustrative block diagram of controller **145** of FIG. 1. This subsystem may include processor **210**, which may, for example be a microprocessor or other type of processing unit. Controller **145** may include local memory **220**. Memory **220** may be used for storing software **225**, which may run in processor **210**. Memory **220**

may also be used to store data **227**, which may also be used by processor **210**. Controller **145** may also include additional control circuitry **230**, which may be used, for example, for communication with other subsystems in enhanced radio system **10** (FIG. 1) (ERS), and to process data sent to and received from the other subsystems.

5           FIG. **3A** shows another illustrative block diagram of an ERS and multiple radio sources. This figure shows that a single system may have multiple radio sources **100** (FIG. 1) of multiple types. For example, the system may include FM radio antenna **310**, AM radio antenna **312**, satellite radio antenna **314**, cable radio signal input **316**, and Internet radio input **318**. These types of radio sources are merely illustrative. An  
10   enhanced radio embodiment may include any combination of these and other types of radio sources.

          FIG. **3B** shows an illustrative block diagram of an embodiment **320** performing the function of a portion of an ERS of FIG. 1. In particular, an example of radio source **100** is embodied in analog radio signal input **325**. Radio receiver **110** and digitizer **115**  
15   are embodied in tuner **330**, demodulator **332**, decoder **334**, and demultiplexor **336**. In this embodiment, digital radio content may be received in analog radio signal input **325**. Tuner **330** may tune the carrier frequency for the digital radio content. Demodulator **332** may demodulate the signal from the format modulated when broadcast. Decoder **334** may decode the particular digital encoding scheme (e.g., MPEG-2) used to carry the  
20   digital data within the signal. Demultiplexor **336** may extract the digital radio data for a particular radio station from several digital radio stations that may be multiplexed within the single carrier signal. The digital data may then be stored into memory **120**.

          FIG. **3C** shows an illustrative block diagram of another embodiment **340** performing the function of a portion of an ERS of FIG. 1. In this embodiment, radio  
25   source **100** is embodied in Internet **345**, and radio receiver **110** and digitizer **115** are embodied in modem **350** and computer **355**. Computer **355** may retrieve radio data from Internet **345** using modem **350**. Modem **350** may be, for example, a wireless, telephone, DSL, or cable modem. Modem **350** may also be used as communications device **155**. Computer **355** may store radio data in memory **120**. User controls **140** may be embodied  
30   in mouse **360** and keyboard **365**. Display device **150** may be embodied in monitor **370**.

Digital-to-analog converter **125** may be embodied in sound card **380**, and audio output **130** may be embodied in speakers **385**.

FIG. **4** shows illustrative block diagram of communications device **155** of FIG. **1**. Communications device **155** may be used by an ERS for receiving data from and sending data to external systems. Communications device **155** may include modem **410**, which may be, for example, a telephone, wireless, cable, or DSL modem. Communications device **155** may include wireless transceiver **420**, which may be, for example, a paging transceiver. Communications device **155** may include computer networking equipment **430**, which may include, for example, appropriate Ethernet hubs, routers, Ethernet transceivers, wireless Ethernet transceivers, and the like. Computer networking equipment **430** may connect enhanced radio system to an in-home network, for example, which may in turn be used for accessing an external network, such as the Internet. Communications device **155** may include portable memory device **440**, which may, for example, be a flash memory card, a smart card, a PDA, etc. Portable memory device **440** may be used for transferring data between an ERS and an external system.

In other embodiments (not shown), communications device **155** may be included as part of radio receiver **110** of FIG. **1**. For example, in an enhanced radio system that accesses Internet radio, the same communications device may be used to acquire the radio data and to communicate data to and from an external system.

FIG. **5A** and FIG. **5B** show illustrative flow charts **500** and **550**, respectively, of a process used by an ERS (FIG. **1**) to acquire and play radio signals. In step **510** of FIG. **5A**, an ERS may receive radio input, for example using radio receiver **100**. In step **520**, the radio input may be stored in memory **120**. If it is determined that the signal is analog in step **511**, the signal may be digitized in step **525** prior to storing it. In step **530**, a user may be allowed to control the storing of radio data, using, for example, user controls **140**. In step **535**, older stored radio data may be overwritten. For example, the radio data may be stored in a circular buffer, and the newest data may continuously overwrite the oldest data as the newest data is written. The size of the circular buffer may be fixed, it may be variable based on available memory, or it may be controlled by the user. The size of the circular buffer may be changed over time.



In step **560** of FIG. **5B**, an ERS may convert the stored radio data to an analog signal, using digital-to-analog converter **125**. The analog audio signal may be output in step **570** to audio output **130**. The user may be allowed to control the outputting in step **580**, using user controls **140**.

5 Steps **510** through **535** of FIG. **5A** may occur in parallel to and independently from steps **560** through **580** of FIG. **5B**. In other words, referring to FIG. **1**, while a radio signal is being stored in memory **120**, a different radio signal may be extracted from memory **120**, digitized and output. The different radio signal may have been stored at an earlier time, and may have been acquired from a different radio source, and/or using a  
10 different radio receiver. Controller **145** directs radio receiver(s) **110** to receive specific sources, and directs digital-to-analog converter **125** to output a different specific set of data, based on input received from user controls **140**.

FIGs. **6A**, **6B**, **6C** and **6D** show four specific embodiments of an ERS. FIG. **6A** shows an enhanced radio embodiment **600** configured to be used in an automobile.  
15 Enhanced radio unit/front panel **610** may be mounted in the automobile dashboard **605** and connected to the automobile antenna **606** and sound system **608** (e.g., amplifiers and speakers). Front panel **610** may include a variety of buttons and other controls, such as volume controls **612**, tuning controls **614**, AUDIO button **616**, SOURCE button **618**, SCAN button **620**, SEARCH button **622**, and PRESET/NUMBER buttons **624**. Front  
20 panel **610** may also include REWIND button **626** for rewinding radio content, PAUSE button **628** for pausing radio play, FAST-FORWARD button **630** for fast-forwarding through radio content, SKIP-BACK button **632** for skipping back to earlier radio content, PLAY button **634** for resuming radio play, SKIP-FORWARD button **636** for skipping forward to later radio content, LIKE button **638** for indicating preferred radio content,  
25 DISLIKE button **640** for indicating radio content that is not preferred, and RECORD button **642** for recording radio content. Front panel **610** may include display **644** and voice input **648**. Any of these controls may also be available on a remote control (not shown). Front panel **610** may also include connector **646** for communications device **155** (FIG. **1**). Connector **646** may be, for example, a connector for a mobile telephone, or a  
30 PC Card slot for a memory card.

FIG. **6B** shows an enhanced radio embodiment **650** configured to be used portably. It includes a main unit **652**, which may include controls **654** and mounting means **656**. Controls **654** may be substantially similar to controls shown in FIG. **6A**. Mount may be configured, for example, to attach to a user's clothing. Embodiment **650** may also include speakers (e.g., headphones) **658**, antenna (not shown), and connection **659** (e.g., wireless or wired) for sending audio signals from main device **652** to speakers **658**. It may also include connector **662** for connecting to communications device **155** (FIG. **1**). Connector **662** may be, for example, a telephone connector or an Ethernet connector, or a PC Card slot for a memory card. Embodiment **650** may alternatively contain communications device **155**, which may be, for example, an infrared transceiver or a radio frequency transceiver.

FIG. **6C** shows an enhanced radio embodiment **670** configured to be used in an environment such as a home or office. Embodiment **670** may include main unit **672**, which may include front panel **674**. Remote control **676** may also be used. Main unit **672** may be connected to speakers **678**, recording device **680**, antenna **684**, or other components of a home entertainment system. Subsystems such as amplifiers and speakers may be incorporated into the enhanced radio system main device, or they may be external to it, allowing a user to connect to existing equipment. Embodiment **670** may also include connector **682** for connecting to communications device **155** (FIG. **1**). Connector **662** may be, for example, a telephone connector or an Ethernet connector, or a PC Card slot for a memory card. Embodiment **670** may alternatively contain communications device **155**, which may be, for example, an infrared transceiver or a radio frequency transceiver.

FIG. **6D** shows an enhanced radio embodiment **690** configured to be used in a shower **692**. Embodiment **690** may be design to be resistant to the heat and moisture found in a shower. It may include keypad **694**, display **698** and communications device **696**. Other components may be sealed inside of the unit. For example, embodiment **690** may include a clock **699**.

FIG. **7** shows process **700** for configuring the enhanced radio system for different environments. In step **710**, the system may be configured to be used in a stationary

environment, such as a home or office. This may include allowing the system to be connected to a user's home entertainment system. It may include higher quality sound components than might be used in a more mobile environment. It may also include a design that is suited for placement on a shelf, in a rack, in a home entertainment console, or the like. In step **715**, the system may be configured to be used in a shower. This may include designing the system to be resistant to heat and moisture. In step **720**, the system may be configured to be used in an automobile. This may include configuring the system to be mounted in a car's dashboard and to be connected to a car audio system. It may also include configuring the controls for the convenience of a driver, such as having buttons that are easy for a driver to see and activate, or including a voice control. In step **730**, the system may be configured to be portable. This may include using light components and designing for durability. It may also include a mounting system that can be worn, and the ability to connect to headphones or other portable speaker systems.

In step **740**, the user may configure the system to be used in multiple environments, so that, for example, a single enhanced radio system may be used both portably or in the car, or in the car or at home. The steps in this process may be performed in any order, and all steps are optional.

Figure **8** shows more details of step **740** of FIG. **7**. In step **810**, the user may be given the ability to change the output device. For example, the user may be able to easily disconnect the headphones and connect a main device to a car audio system, to convert a system from a portable environment to the car environment. In step **820**, the user may be given the ability to change the user input device. For example, the user may be able to use a front panel in one environment and a remote control in another. In step **830**, different mounts may be provided. For example, the system may be mounted both in an automobile dashboard and on the user's clothing. In step **840**, the user may be allowed to change the communications device. This may include, for example, connecting to a mobile telephone modem in an automobile and connecting to an in-home network at home. In step **850**, the user may be given the ability to connect to different radio sources. For example, the user may connect the system to a car antenna when the system is mounted in a car, and may connect the system to a home network and a cable radio

system when using the system at home. The steps in this process may be performed in any order, and all steps are optional.

The enhanced radio system may also be implemented as components in a modular personal network system, as disclosed in concurrently filed U.S. Patent Application

5 "Modular Personal Network," by Michael D. Ellis and Caron S. Ellis, which is hereby incorporated by reference in its entirety. In that invention, multiple personal devices may be connected via a wireless network. Devices may be added or removed to change the functions of the system. For example, a radio receiver and digitizer may be one individual network component. The controller and memory may be another individual

10 network component. Other individual network components may also include user controls, display device, and digital-to-analog converter/audio output. In such embodiments, the user may change individual network components to use the invention in different environments. For example, the user controls for a portable enhanced radio system may be worn on the person, while the user controls for a car enhanced radio

15 system may be mounted in the car. Similarly, the audio output for the personal enhanced radio system may be portable headphones, while in the car the car's audio system may be used. In such embodiments, software, audio, and other data may be downloaded into the system from a base station or personal computer.

An ERS may allow a user to control the outputting of the radio signal. FIG. 9

20 shows process 900 for providing user control of the radio output, and is illustratively discussed in conjunction with the block diagram of FIG. 1 and the embodiment of FIG. 6A. The steps in this process may be performed in any order, and all steps are optional. In step 910, the user may be allowed to pause the radio output, for example by pressing PAUSE button 628. The system may temporarily cease sending an audio signal to audio

25 output 130. In substep 912, the system may continue to store the incoming radio signal to memory 120. This may allow the user to listen to that radio content at a later time.

In step 920, the user may be allowed to play or resume the radio output, for example by pressing PLAY button 634. The system may resume sending an audio signal to audio output 130, and may resume from the same point at which the user earlier

30 paused. In substep 922, the system may continue to store the incoming radio signal to

memory 120. This may allow the user to "catch up" to the current radio content at a later time.

In step 930, the user may be allowed to skip-back to earlier radio content, for example by pressing SKIP-BACK button 632. This feature may allow the user to skip-  
 5 back to the start of a song, traffic report, weather report, or other radio content of interest, to listen again to a phone number or clue for a radio contest, to hear public radio pledge information again, or to repeat any other content of interest. The system may immediately begin sending audio signal to audio output 130 corresponding to audio that was stored at a time earlier than the audio signal currently being sent to audio output 130.  
 10 The amount of time to skip-back may be user-specified, as in substep 932. For example, the user may be able to choose between skipping back 5, 10, or 30 seconds. The amount of time to skip-back may be predetermined by the enhanced radio system, as in substep 934. For example, the enhanced radio system may always skip-back 10 seconds. The amount of time to skip-back may be content-specific, as in substep 936. For example, the  
 15 enhanced radio system may always skip-back 15 seconds during commercials and 30 seconds during songs. Or, the enhanced radio system may always skip-back to the start of the currently playing content. The choice of which substep to perform may be user selected or factory defined.

In step 940, the user may be allowed to skip-forward to later stored radio content, for example by pressing SKIP-FORWARD button 636. This feature may allow the user  
 20 to skip to the end of a commercial, public radio pledge drive solicitation, or other radio content not of interest. The system may immediately begin sending audio signal to audio output 130 corresponding to audio that was stored at a time later than the audio signal currently being sent to audio output 130. The amount of time to skip-forward may be  
 25 user-specified, as in substep 942. For example, the user may be able to choose between skipping forward 5, 10, or 30 seconds. The amount of time to skip-forward may be predetermined by the enhanced radio system, as in substep 944. For example, the enhanced radio system may always skip-forward 30 seconds. The amount of time to skip-forward may be content-specific, as in substep 946. For example, the enhanced  
 30 radio system may always skip-forward 15 seconds during commercials and 30 seconds



during songs. Or, the enhanced radio system may always skip-forward to the end of the currently playing content. The choice of which substep to perform may be user selected or factory defined.

In step 950, the user may be allowed to rewind the radio content, for example by pressing REWIND button 626. This feature may allow the user to listen to a song or other radio content of interest again. The system may immediately begin sending audio signal samples in reverse order to audio output 130 corresponding to audio that was stored at a time earlier than the audio signal currently being sent to audio output 130. The user may be allowed to rewind at multiple speeds, as in substep 952. For example, if the user presses REWIND button 626 a second time, the system may change to a faster rewind speed, cycling through the available rewind speeds as the user repeatedly presses REWIND button 626. The audio signal samples may be chosen further apart and/or the audio signal samples may be shorter in duration if the user chooses a faster rewind speed. The system may provide frequency compensation in substep 954, so that the audio signal samples are recognizable by the user even if played at a different speed than they were recorded at. The system may stop rewinding when the user presses REWIND button 626 again after accessing all available rewind speeds. Alternatively, the system may stop rewinding when the user presses PLAY button 634 or PAUSE button 628.

In step 960, the user may be allowed to fast-forward the radio content, for example by pressing FAST-FORWARD button 630. This feature may allow the user to quickly get through a commercial or other radio content not of interest. The system may immediately begin sending audio signal samples at a higher rate in forward order to audio output 130 corresponding to audio that was stored at a time later than the audio signal currently being sent to audio output 130. The user may be allowed to fast-forward at multiple speeds, as in substep 962. For example, if the user presses FAST-FORWARD button 630 a second time, the system may change to a faster fast-forward speed, cycling through the available fast-forward speeds as the user repeatedly presses FAST-FORWARD button 630. The audio signal samples may be chosen further apart and/or the audio signal samples may be shorter in duration if the user chooses a faster fast-forward speed. The system may provide frequency compensation in substep 964, so that



the audio signal samples are recognizable by the user even if played at a different speed than they were recorded at. The system may stop fast-forwarding when the user presses FAST-FORWARD button **630** again after accessing all available fast-forward speeds. Alternatively, the system may stop fast-forwarding when the user presses PLAY button **634** or PAUSE button **628**.

In step **970**, the user may be allowed to slow-play the radio content, for example by pressing PLAY button **634** while the system is playing radio content at normal speed. This feature may allow the user to listen more closely to radio content of interest, or to more precisely find a point of interest in the content. The system may immediately begin sending audio signal samples at a slower rate in forward order to audio output **130** corresponding to audio that was stored at a time later than the audio signal currently being sent to audio output **130**. The user may be allowed to slow-play at multiple speeds, as in substep **972**. For example, if the user presses PLAY button **634** again while already slow-playing, the system may change to a slower slow-play speed, cycling through the available slow-play speeds as the user repeatedly presses PLAY button **634**. The audio signal samples may be chosen closer together and/or the audio signal samples may be longer in duration if the user chooses a slower slow-play speed. The system may provide frequency compensation in substep **974**, so that the audio signal samples are recognizable by the user even if played at a different speed than they were recorded at. The system may stop slow-playing when the user presses PLAY button **634** again after accessing all available slow-play speeds. Alternatively, the system may stop slow-playing when the user presses PAUSE button **628**. The system may also allow the user to slow-play in the reverse direction, for example, as one or more additional rewind speeds.

While the system is rewinding, fast-forwarding, or slow-playing, the system may continue to store new radio content to memory **120**. This may allow the user to "catch up" to the current radio content at a later time.

The system may allow the user to record a portion of the radio input in memory **120** (FIG. 1) for later playback. FIG. 10A shows process **1000** for recording radio content for the user, and is illustratively discussed in conjunction with the embodiment of FIG. 6A. The steps in this process may be performed in any suitable order, and steps

may be omitted if desired. In step **1010**, the user may be allowed to specify the content to be recorded. In step **1020**, the system may record the content in memory **120**. For example, the content may be copied from the circular buffer into a separate area of memory **120**. This may involve copying more than one block of memory, if the content of interest spans the start and end of the buffer in memory, or if the circular buffer is implemented with multiple blocks of memory.

In step **1030**, the user may be allowed to select the recorded content as a "preset" station. If an ERS includes a "preset station" feature, allowing a set number of radio stations to be quickly tuned, e.g., at the touch of a single PRESET button **624**, the system may allow the recorded content to be saved as one of the presets. In other words, the content may later be replayed at the touch of a single PRESET button **624**.

Even if recorded content is not saved as a preset, the system may allow the user to replay the recorded content at a later time in step **1040**. For example, the system may present a list of previously recorded radio content items. If the user selects an item from the list and presses PLAY button **634**, the system may begin playing the content item as if it were currently being broadcast. Controls such as pause, skip-back, skip-forward, etc., may be allowed while the content item is being played. Upon reaching the end of the recorded content item, the system may stop, may automatically begin playing the content item from the beginning, may return to the most recent radio station, or another appropriate action.

In step **1050**, the user may be allowed to store the content item to an external recording device. This may include, for example, recording device **680** shown in embodiment **670** of FIG. **6C**. The external recording device may be, for example, a cassette recorder, a CD recorder, or other device capable of storing analog or digital audio. This feature may allow the user to maximize use of the limited memory **120**, while saving a more permanent copy of the desired radio content.

FIG. **10B** shows more details of step **1010**, allowing the user to specify the content to be recorded. The steps in this process may be performed in any order, and all steps are optional. In step **1012**, the user may be allowed to specify the start and end of the content to be recorded. For example, the user may rewind to the start of the content

of interest using REWIND button **626** or SKIP-BACK button **632**, and then press RECORD button **642** to indicate the start of the content to be recorded. The user may then use the PLAY button, **634**, FAST-FORWARD button **630** or SKIP-FORWARD button **636** to find the end of the content of interest, and then press RECORD button **642**  
 5 again to indicate the end of the content to be recorded.

In step **1014**, the user may be allowed to indicate any point during a radio item of interest, for example by pressing RECORD button **642**. The system may automatically determine the start and end of the content of interest using audio cues. Audio cues may be algorithmically determined points in the audio content, based on, for example, silence  
 10 in the audio, changed frequency content of the audio, changed power content of the audio, and changed rhythmic content of the audio, combined with the length of the audio segment. Refer to discussion of FIG. **15** below for more details on audio cues. Cues may have already occurred and may be extracted from radio data stored in memory **120**. Cues may also occur at some time after the user indicates the item to be recorded. The system  
 15 may also use a combination of steps **1012** and **1014**, allowing the user to specify one end point of the content to be recorded and determining the other automatically.

In step **1016**, the user may be allowed to specify a radio station, and start time, and an end time. Instead of an end time, the user may be allowed to specify duration. For example, if an ERS includes a computer monitor **370**, keyboard **365**, and mouse **360**,  
 20 as shown in embodiment **340** of FIG. **3C**, the system may present a list of radio stations on monitor **370**, allow the user to select a station with mouse **360**, and then allow the user to type the start and end time using keyboard **365**.

In step **1018**, the user may be allowed to select an item from a schedule of radio programming to be recorded. For example, the system may display a list of stations on  
 25 monitor **370** and allow the user to select one with mouse **360**. The system may then display a list of programs scheduled on the selected station, and allow the user to select one of the programs for recording.

In FIG. **11**, flow chart **1100** shows an illustrative process for downloading audio content into an ERS, and is illustratively discussed in conjunction with the block diagram  
 30 of FIG. **1** and the embodiment of FIG. **6A**. This process may allow the user to

incorporate some favorite songs into the system and play them instead of a radio station at any time, using the resources of the enhanced radio system. The user does not need to purchase a separate recorded music player. In step 1110, the user may be allowed to download audio content, such as a song, using communications device 155. In step 1120, the audio content may be stored into memory 120. In step 1130, the system may allow the user to assign the downloaded audio content to one of PRESET buttons 624. In step 1140, the system may allow the user to replay the downloaded content. If desired, any of these steps may be omitted or performed in an alternate order.

FIG. 12 shows illustrative screen 1200 that may be displayed on monitor 370 (FIG. 3) to allow the user to select an item to be recorded. Selection 1210 may allow the user to instruct the system to record the current song, as disclosed with regard to steps 1110 and 1120 of FIG. 11 above. Selection 1220 may allow the user to instruct the system to record content based on station, start time, and end time, as disclosed with regard to step 1130 of FIG. 11 above. Selection 1230 may allow the user to instruct the system to record a specific radio program scheduled to air on a specific radio station at a specific time, as disclosed with regard to step 1140 of FIG. 11 above.

In FIG. 13 we present flow chart 1300, showing an illustrative process used by an ERS to support a preset station feature, illustratively discussed in conjunction with the block diagram of FIG. 1 and the embodiment of FIG. 6A. The steps in this process may be performed in any suitable order, and any steps may be omitted if desired. In step 1310, the system may allow a user to select one or more radio stations as favorites. The user may, for example, press and hold one of five PRESET buttons 624 to set the currently playing radio station as one of five favorites. In substep 1312, the user may be allowed to select recorded radio content as a favorite, as discussed previously in conjunction with flow chart 1000 of FIG. 10. In substep 1314, the system may treat one or more recently tuned stations as a favorite station. For example, the system may keep track of the most recently tuned one or two stations.

In step 1320, the user may be allowed to quickly tune to a favorite radio station. If a radio station was selected as a preset station in step 1310 above, the user may be allowed to quickly select that station by pressing the same PRESET button 624 that was used to

select it as a favorite. If a user has selected recorded content, such as a song, as one of the favorites, then the user may be allowed to quickly access that content by pressing the corresponding one of PRESET buttons 624. The system may also have a button (not shown) to quickly access a recently tuned radio station.

5 In step 1330, an ERS may continuously store content from the favorite stations in memory 120. This may be, for example, in a circular buffer, as in substep 1332. The system may also use other data structures, such as linked lists of stored audio segments. An ERS may have one tuner allocated to each of the favorite stations, to continuously record the most recent content on that station, even while the user is listening to another  
10 station. For example, the system may include one tuner dedicated to the station that the user is currently listening to, one tuner dedicated to the most recently tuned station, and one tuner dedicated to each of six preset stations. Each of these tuners may be independently tuned to a different source and station. The input from each of these tuners may simultaneously be digitized and stored into independent areas of memory. The  
15 amount of audio data stored for each station may be the same, or it may be individually configured for each station. For example, the system may record the most recent five minutes of audio from each of six favorites, plus the most recent ten minutes of audio from the previously tuned channel, plus the most recent twenty minutes of audio from the radio station the user is currently listening to.

20 When the user selects a different radio station and that station is one of the user's favorites or a station the user has listened to recently, the system may have in memory 120 several minutes of content prior to when the user selected the new station. In step 1340, an ERS may allow the user to listen to content broadcast prior to the time the user selected the station. For example, the user may press one of PRESET buttons 624 to  
25 switch to a favorite station, recognize the middle of a favorite song, and use SKIP-BACK button 632 or REWIND button 626 to begin playing at the beginning of the song. The system will continue to record the input from the newly selected station into memory 120, and may also continue recording the input from the previous station.

The system may also keep track of user radio preferences, and may have the  
30 ability to recognize specific content items, such as songs, that the user may like. In step



1350, the system may monitor favorite stations (e.g., preset stations and recently tuned stations) for content of interest, i.e., content that matches the user's preferences. This may include step 1352 in which the user is allowed to specify content preferences. For example, a user may specify specific songs, artists, radio shows, types of content (e.g.,  
 5 traffic or weather reports), categories of music, or other content, and specify a level of like or dislike for that content. For example, the user may press LIKE button 638 or DISLIKE button 640 while a song is playing to indicate a preference for or against the song. In an embodiment with a personal computer, the system may present a screen such as screen 2000 of FIG. 20, discussed below, to enable the user to specify content  
 10 preferences. User preferences may be loaded using communications device 155. The system may also determine user preferences automatically by monitoring what content the user listens to.

In substep 1354, the system may recognize content of interest on one of the monitored radio stations. This may be based on a number of factors including a schedule  
 15 of events for the monitored station, identification information sent with the radio content, or matching a stored "audio signature" against the incoming content. An audio signature may be created, for example, by sampling the power level of 16 different frequencies at several different offsets from the start of the song. A method of creating and recognizing audio segments using an audio signature is disclosed in U.S. Patent No. 5,612,729 (1997)  
 20 to Ellis et al., "Method and system for producing a signature characterizing an audio broadcast signal," which is hereby incorporated by reference herein in its entirety.

At fixed intervals, e.g., thirty times per second, the system may calculate a 16-bit signature value representative of the audio at that point in time. Each of the 16 bits may represent whether the power level of a specific frequency band is increasing or  
 25 decreasing at that point in time. The system may also generate a 16-bit mask value at each of the same times, with each bit in the mask value determining whether the corresponding bit in the signature word is considered reliable.

To create a signature for a song, the system may take a number of signature/mask pairs at various offsets from the start of the song. One of the signature words may be  
 30 considered the "keyword," and may be selected based on providing the most likely



correct match. The system may store the offset of the keyword from the start of the audio segment. Additional signature/mask pairs may be stored, along with their offsets relative to the keyword. Keywords and other signature words may be selected based on run length (how long the signature word is constant), how quickly the signature values  
 5 change at the end of the run, number of mask bits set, similarity to other signatures, avoiding the start and end of the segment, and other factors.

To recognize incoming audio, the system may compare signature words from the incoming digitized audio against the keyword for all segments of interest. When a keyword match is found, the system may then compare the other signature words from  
 10 the song of interest with the signature words in memory corresponding to the incoming audio signal, at the appropriate signature offsets from the matching keyword. If an acceptable level of matching of the complete signature is found, then a match is reported.

Assuming that the signature words are distributed fairly evenly throughout the song, the song cannot be recognized until after most of the song has been broadcast.  
 15 However, because the audio for the past several minutes is stored in memory 120, the user will be able to listen to the song from the beginning after switching to it.

This method of using audio signatures to recognize incoming content is merely illustrative. Other methods may be used for audio signature creation and matching.

After the system recognizes an item of interest, the user may be notified in step  
 20 **1360**. The notification may include the name or other information about the content, or it may just indicate that something of interest has been found. For example, an audio notification may be sent to audio output 130. Alternatively or in addition, a message may be displayed on display device 150. The notification may also indicate that the user may quickly switch to the content of interest, for example by pressing a button, as in step  
 25 **1362**. After the user switches to the new station, the system may allow the user to skip-back to the start of the content of interest, as in step **1364**, for example using SKIP-BACK button 632. Alternatively, the system may automatically skip-back to the start of the content of interest when the user selects it, as in step **1366**.

After the system recognizes an item of interest, it may automatically switch the audio output to the station that broadcast the content in step 1370. In step 1372, the user may be allowed to skip-back to the start of the content of interest, for example using SKIP-BACK button 632. Alternatively, in substep 1374, the system may automatically skip-back to the start of the content of interest after automatically switching to the station that broadcast it.

The system may support identification of specific pieces of audio content, such as songs and commercials. FIG. 14 is a flow chart of process 1400 for identifying and tracking items of audio content. The steps in this process may be performed in any order, and all steps are optional. In step 1410 an item of audio content is first identified. This identification may be based on user indication or on cues in the audio, as discussed in more detail with respect to FIG. 15 below. In step 1420, the item of audio content may be stored, as described in conjunction with FIG. 10 above.

In step 1430, the user may be allowed to enter information about the audio item. For example, this may include the type of content (song, commercial, weather report, etc.), the name of the item, the artist (for example, if the item is a song), and the advertiser (for example, if the item is a commercial). In step 1440, the system may acquire information about the item from an external source. The information acquired from an external source may be more extensive than that entered by the user, as it may be loaded from a database of detailed information about songs or other content. The information about the content may be acquired from the radio signal along with the content itself in substep 1442 (or from a separate radio signal using a separate radio receiver), it may be downloaded using a communications device 155 (FIG. 1) such as a modem in substep 1444, or it may be read from a removable portable memory device 440 (FIG. 4) in substep 1446. Whether entered by the user or acquired from an external source, the information about the content may be stored in memory 120 (FIG. 1) and associated with the stored content.

The information about the content item acquired from an external source may include a unique identifier, in step 1450. For example, every song that might be played might be assigned a unique number as an identifier. The identifier may be broadcast with

the song. The system can then look up that identifier in a database of song information to retrieve other information about the song.

In step **1460**, a unique audio signature may be associated with the content. The audio signature may be generated locally by the enhanced radio system in substep **1462**,  
 5 or the audio signature may be acquired from an external source in substep **1464**. The audio signature may be stored with the other information about the item of content. In step **1470**, the system may recognize the item of content when it is broadcast. The item may be recognized when it is broadcast on the station that the user is listening to, or it may be recognized when it is broadcast on another station that the system is monitoring.  
 10 The item of content may be recognized using the previously stored audio signature, in substep **1474**. Alternatively, in step **1472**, the item of content may be recognized based on identification information broadcast with the item of content on the radio station or received via communications device **155** (FIG. 1). This identification information may, for example, be the previously stored unique identifier associated with the content.

15 In step **1480**, the system may allow the user to rate an item of content. For example, the user may specify that he likes or dislikes a particular song or commercial. The system may also allow the user to specify levels of interest, such as a strong like or weak preference. In step **1490**, when the system recognizes an item of content that the user does not like, it may automatically skip over that content. For example, if the user is  
 20 listening to a radio station a significant amount of time prior to the radio data that is being stored for the same station, the system may skip the disliked content and immediately begin playing the content stored immediately following the disliked content. Alternatively, the system may switch to a radio station with more preferred content when disliked content is recognized. In steps **1492** and **1494**, the system may notify the user or  
 25 automatically switch when preferred content is recognized on a station the user is not currently listening to, as discussed above with regard to FIG. 13.

FIG. 15 shows more details of step **1410** of FIG. 14, identifying an item of radio content, and is illustratively discussed in conjunction with the block diagram of FIG. 3 and the embodiment of FIG. 6A. The steps in this process may be performed in any  
 30 order, and all steps are optional. At **1510**, the item may be identified based on a user

indication. In substep **1512**, the user may be allowed to indicate the start of the item, for example by pressing LIKE button **642** when listening to the start of the item. In substep **1514**, the user may be allowed to indicate the end of the item, for example by pressing LIKE button **642** a second time when listening to the end of the item. The user may also  
 5 be allowed to select the item from a radio schedule in substep **1516**. The schedule may, for example, be displayed on monitor **370**, and the user may click on a desired item in the schedule, using mouse **360**.

In step **1520**, the system may identify an item at least partially based on its duration. In substep **1522**, identification based on duration may be combined with other  
 10 cues. For example, a user may indicate a single point in time during the item, and the system may identify an item based on duration incorporating the indicated point. The system may use typical durations of items based on type of content in substep **1524**. For example, the system may identify commercials that are 30 or 60 seconds long. The system may identify songs that are between three and six minutes long. The system may  
 15 assign probabilities to different durations or ranges of durations, and pick a duration based on other cues and the highest probability duration.

In step **1530**, the system may identify an item based on cues in the audio. Cues may indicate a specific short event in the audio, such as silence, in substep **1532**. In some cases a brief silence may be indicative of a transition between two different content  
 20 items. Alternatively, an audio cue may be determined by monitoring a characteristic of the audio for changes that may indicate different content.

For example, in substep **1534** the system may monitor frequency content of the audio. The frequency content may be determined, for example, by performing a Fourier transform on the input audio waveform. When transitioning from one item of content to  
 25 another, such as two songs or a song and a commercial, the frequency content may exhibit significant changes that may not typically occur within a single item. One song may be in one musical key and the following song may be in a different musical key, or a song may be followed by a commercial that is mostly speaking.

In substep **1536**, the system may monitor the power content of the audio. The  
 30 power level, such as the peak power level or the average power level, may change from

one item of content to another. For example, the average power level may be increased during a commercial.

In substep **1538**, the system may monitor the rhythmic content of the audio. The rhythmic content may be determined using a Fourier transform, similar to the frequency content. One song may have a strong rhythmic content that varies from the rhythmic content of a following song. Or, a spoken commercial may not have a strong identifiable rhythmic content.

The different methods of identifying an item of audio content may be combined in various ways. For example, the system may identify several possible transition points between two songs, may pick the most likely based on common durations, and then may allow the user to fine tune the identification of the start and end point.

FIG. **16** shows an illustrative data structure **1600** that may be used to store information about a content item. Field **1605** may store the duration (e.g., in seconds) of the item. The duration may also be measured in units of data storage required for the item, such as bytes. The record may also store a compression factor if necessary to determine how to decompress the audio data. Field **1610** may store a pointer to the stored audio content. This may be a pointer to the block of memory holding the audio data, a pointer the first block of data if the audio data is stored in multiple blocks, a list of addresses of multiple memory blocks used to store the audio data, a file name of audio data stored on a disk drive, or other such pointer.

Field **1615** may store the name of the item. This may be, for example, the name of a song, the name of a product advertised, the name of a radio show or news/information segment, or a name assigned by the user. Field **1620** may store the name of the artist, for example if the item is a song. Field **1625** may store the type of content, such as whether the item is a song, commercial, news show, etc. Field **1630** may store the advertiser, if the content is a commercial.

Field **1635** may store a unique identifier for the item of content. Field **1640** may store an audio signature for the item. It may alternatively store a pointer to the signature, which may be stored in a separate part of memory **120** (FIG. 1) or other memory. Field

**1645** may store a user rating for the item. For example, it may indicate whether the user likes or dislikes the item, and may indicate a level of user preference. Field **1650** may store a link to a web site related to the item. Field **1655** may store a parental rating for the item, such as a content advisory. Field **1660** may store the name or identifier of one or more groups that the item may be a member of, such as music of particular type. These fields are merely illustrative, and need not be present in all embodiments. Data structure **1600** may also include other fields if desired.

FIGs. **17A** through **17C** illustrate data related to the audio signal that may be used to identify an item and differentiate it from another adjacent item. Graph **1700** of FIG. **17A** shows power **1705** vs. time **1710** for an incoming audio signal. This graph shows an initial portion **1712** of the audio with one power characteristic, a second portion **1714** of the audio with a second audio characteristic, and a third portion **1716** of the audio with a third characteristic. In this example, second portion **1714** corresponds to a period of silence, and third portion **1716** has a higher peak and average power than first portion **1712**.

Graph **1720** of FIG. **17B** shows power **1725** vs. frequency (time) **1730** for a sample from an audio signal. The time scale of this graph highlights the rhythmic content of the audio. From this graph it can be seen that the audio signal has a significant rhythmic content at about two beats per second. Aspects of the rhythmic content of the incoming audio may remain constant through a song, and may change when another song begins. An incoming period with no music may not have a strong rhythmic content.

Graph **1740** of FIG. **17C** shows power **1745** vs. frequency **1750** for a sample from an audio signal. This graph is based on a shorter sample period and a faster frequency range than graph **1720**. The range of frequencies sampled corresponds to the range of frequencies found in voice and music audible to human hearing. This graph shows the power present in the range of frequency bands for the audio sample. Aspects of frequency content of a song may be fairly constant during the song, and may subsequently change when another song or a commercial begins.

In FIG. **18**, flow chart **1800** shows an illustrative process for supporting groups of items of audio content. All steps in this process are optional, and may be performed in



any suitable order. In step **1810**, items of audio content may be grouped. Groups may be created by the user, programmer, or advertiser, based on a number of criteria. In step **1820**, a user may be allowed to rate a group. The user may specify a like or dislike, or a level of like or dislike, for a specific group of content. The system may also monitor the content listened to by the user, and automatically determine the groups liked and disliked by the user. In step **1830**, the system may automatically recognize an item in the group when it has been broadcast. For example, the system may recognize a specific item as described above, using an audio signature, unique identifier, information broadcast with the item in the radio signal, program schedule, or other means. The system may then determine the groups in which the recognized item is a member. Alternatively, the system may directly recognize the group itself, for example based on a published schedule or on information broadcast with the radio signal. In step **1840**, the system may automatically skip over an item that recognized to be a member of a group that the user dislikes, when it occurs on a radio station currently being listened to by the user. For example, a parent may define a group in a child's ERS based on an unacceptable parental advisory level, and the system may be configured to skip over all content in that group. In step **1850**, the system may notify the user when it recognizes an item that is a member of a group liked by the user when it occurs on a station not being listened to by the user but that is being monitored by the system. If desired, this notification may occur even when the user is performing an activity other than listening to the radio, for example when the ERS is turned off, or when the user is listening to an audio tape or compact disk. In step **1860**, the system may automatically switch to the radio station broadcasting an item of interest when it is recognized on a station not being listened to by the user but that is being monitored by the system, if that item is a member of a group liked by the user. Additionally, the system may automatically skip-back to the start of the recognized item so that the user can hear it in its entirety. If desired, the automatic switching may occur even when the user is performing an activity other than listening to the radio, for example when the ERS is turned off, or when the user is listening to an audio tape or compact disk.



FIG. 19 shows more detail of step 1810, the grouping of items of audio content, and is illustratively discussed in conjunction with the block diagram of FIG. 3 and the embodiment of FIG. 6A. All steps in this process are optional, and may be performed in any suitable order. In step 1905, groups may be created based on user-specified criteria. For example, the user may enter criteria using keyboard 365, mouse 360, and monitor 370. In another embodiment, the user may specify criteria using buttons on front panel 610 and display 644. Criteria may be specified using voice input 648. Criteria may also be specified by allowing the user to indicate a specific item and creating a group based on a characteristic of the item.

In step 1910, a group may be based on type of content, such as grouping all commercials, all songs, etc. In step 1915, a group may be based on a category of content, such as bluegrass music, alternative rock, or other music genre. In step 1920, a group may be based on a specific performing artist, and may contain all songs performed by that artist. In step 1925, a group may be based a particular radio station, and may contain all content broadcast by that station. In step 1930, a group may be based on a specific radio show, and may contain all content broadcast in that show. In step 1935, a group may be based on a particular parental advisory level.

In step 1940, a programmer may be allowed to specify a grouping. For example, a programmer may decide to highlight and group a set of songs that may appeal to a subset of their listeners. In step 1945, an advertiser may be allowed to specify a grouping. For example, an advertiser may decide to group an ad with several songs that may appeal to a targeted subset of listeners.

In step 1950, other criteria may be used to specify a grouping. In step 1955, groups may be created based on multiple criteria. This may include excluding items that match a criteria, unions of items that meet specific criteria, and intersections of items that meet multiple criteria.

FIG. 20 shows illustrative screen 2000 which may be displayed on monitor 370 (FIG. 3) to allow a user to configure a group. Pull-down list 2010 may allow the user to select a specific group, such as a genre of music. In this example, the user has selected alternative rock. Pull-down list 2020 may allow the user to enter a rating for the group.

In this case, the user has specified that he or she hates alternative rock music. The system may allow the user to enter a preference for or against the group, as well level of interest. For example, the user may be allowed to specify a strong or weak like or dislike, or ambivalence toward the group.

5            Selections **2030** and **2040** may allow the user to specify what the system should do when it recognizes an item from the group. Specifically, selection **2030** allows the user to specify whether the system should automatically skip items in a group that the user does not like. Selection **2040** allows the user to specify whether the system should notify the user or automatically switch stations when it recognizes an item that the user  
10 likes.

FIG. **21** shows illustrative process **2100** for providing radio station recommendations to a user. All steps in this process are optional, and may be performed in any suitable order. For example, a user may be traveling in an unfamiliar region, and may be listening to the enhanced radio system in a personal or rental car. The user may  
15 wish to quickly and easily find stations that match her preferences.

In step **2110** of process **2100**, the system may acquire information about the user's preferences. This step is explained in more detail in FIG. **22**. In step **2120**, the system may acquire information about available radio stations. This step is explained in more detail below, in conjunction with FIG. **23**. In step **2130**, the system may select one or  
20 more recommended stations from the set of available stations, based on the user preferences. This may be done, for example, correlating the play list from each station to the list of songs, artists, and genres selected as likes and dislikes by the user, and choosing the closest match or matches. For example, a score can be created for each station by adding a value for each match to a like and subtracting a value for each match  
25 to a dislike, with each value weighted by the level of like or dislike specified by the user. A higher value may be added for a music genre match, a lower value for an artist match, and a still lower value may be added for a song match. In step **2140**, the system may present one or more of the recommended radio stations to the user. This step is explained in more detail below, in conjunction with FIG. **24**.

FIG. 22 shows more detail of step 2110 of FIG. 21, acquiring user information. All steps in this sub-process are optional, and may be performed in any suitable order. In step 2210, the user may be allowed to enter user information. For example, a screen such as screen 2000 of FIG. 20 may be used by the user to specify likes and dislikes. In step 5 2220, the system may determine user information automatically by monitoring the content the user listens to. For example, the system may add points to a specific song, artist, genre, or other type of item or grouping, based on the user listening to an entire item. The system may assign additional points if the user rewinds or skips back to the start of an item to hear it in its entirety or to hear it again. The system may subtract 10 points if the user skips over an item. In step 2230, the system may download user information. For example, the user may have entered preferences in a web site, and the system may access that web site using communications device 155 (FIG. 1) to obtain that information. The system may also download user information from another enhanced radio system that the user may have previously used. The system may alternatively load 15 the user information from a portable memory device 440 (FIG. 4), such as a flash memory card, a smart card, a PDA, or the like. The user may have loaded the information into the portable memory device 440 from another enhanced radio system. Portable memory device 440 may be used to hold a user profile, and may be loaded into multiple enhanced radio systems as they are used by the user, so that the user's preferences 20 may be available in each location.

FIG. 23 shows more detail of step 2130, acquiring information about available radio stations, and is illustratively discussed in conjunction with the block diagram of FIG. 1. All steps in this sub-process are optional, and may be performed in any suitable order. In step 2310, the system may acquire information about available radio stations 25 from information sent with the radio station the user is listening to. For example, information about the radio station may be embedded in the radio signal, and the system may extract that information and store it. The signal may also include information about other stations that the user is not listening to, but which may be available. The system may collect this information over time as it is sent to create a list of all available radio 30 stations.

In step **2320**, the system may acquire information about available radio stations using a radio receiver not currently being used to play the station the user is listening to. For example, the system may continuously scan the radio spectrum to find each receivable station. When a station is found, the system may read any information that  
 5 may be embedded in the signal identifying the name of the station, the play list, the genres of music played, etc. Alternatively, the system may stay tuned to each station it finds for a period of time and check for any signatures that may match content the user's likes or dislikes.

In step **2330**, the system may download a database of radio stations. The system  
 10 may use communications device **155** (e.g., as shown in the block diagram of FIG. 4, modem **410**, wireless transceiver **420**, networking equipment **430**, or portable memory **440**). The system may download the database from a central server, a web site, another enhanced radio system, or other repository. The database may include, for example, a record for each radio station in the country. For each radio station, it may include the  
 15 broadcast frequency, call letters, station format, list of artists and songs played (i.e., a play list), a schedule of programming, the geographical region served by the station, and any other relevant information.

In step **2340**, the system may use global positioning system monitor **160** to determine the user's location. The location may also be determined by other means, such  
 20 as by allowing a user to enter it, or by monitoring the radio stations that can be received and comparing them against the geographical region field in the radio station database.

In step **2350**, the system may use the current location to filter the database of radio stations. For example, if the database includes a geographical region field for each station, the system may compare the current location with this field and exclude radio  
 25 stations that do not serve the current location. If the enhanced radio system is used in a car, the system may also monitor the current route, or future routes that may be planned by the user, to determine if a radio station will be accessible for a significant period of time.

FIG. **24** shows more detail of step **2140**, presenting the recommended radio  
 30 stations to the user. All steps in this sub-process are optional, and may be performed in

any suitable order. In step **2410**, the system may display a list of recommended radio stations. For example, the list may be displayed on monitor **370** (FIG. 3) or display **644** (FIG. 6A). The user may be allowed to scroll or page through the list if it does not fit on a single display screen. In step **2420**, the user may be allowed to select from the

5 displayed list of radio stations, for example using mouse **360** (FIG. 3), keyboard **365** (FIG. 3), a button on front panel **610** (FIG. 6A), voice input **648** (FIG. 6A), or remote control **676** (FIG. 6C). When the user selects an item from the list, the system may immediately switch to that station, may display more information about the radio station, may assign the radio station to one of the enhanced radio presets, or may take other

10 suitable action.

In step **2430**, the system may automatically set one or more presets based on the set of recommended radio stations. For example, the system may set all available presets based on the stations which best match the user's preferences. The system may assign the single best station to a single preset. Or the system may allow the user to specify how

15 many presets to assign automatically.

In step **2440**, the system may automatically begin playing audio from one of the recommended radio stations. In step **2450**, the system may automatically record content from one of the recommended stations. That may include continuously monitoring the station and storing its digitalized audio to a circular buffer.

20 FIG. 25 shows illustrative data structure **2500** for storing user preferences. It may include field **2510** for storing information about music formats the user likes. It may include field **2520** for storing information about music formats the user does not like. It may include field **2530** for storing information about talk formats the user likes. It may include field **2540** for storing information about talk formats the user does not like. It

25 may include field **2550** for storing information about performing artists the user likes. It may include field **2560** for storing information about performing artists the user does not like. It may also include one or more fields **2570** for storing information about how the user's preferences change over time, for example if the user likes listening to different types of content on different days of the week or at different times of the day. All fields

30 shown are optional, and other information relating to the user's preferences may be

stored. If desired, the enhanced radio system may store the preferences for multiple users.

FIG. 26 shows illustrative data structure **2600** for storing information about a radio station, for example in a radio station database. Field **2610** may store the station call letters or other identifying name. Field **2620** may store the format of the radio station, for example as a text string, or as a selection from a table of known formats. Field **2630** may store a list of performing artists typically played by the station. Field **2640** may include a schedule of programs airing on the radio station. Field **2650** may include information about the geographical region served by the radio station. Field **2660** may store the broadcast frequency, or other information necessary for receiving the station. Field **2670** may include the telephone number of the radio station. All fields shown are optional, and other fields may be included in the radio station database as desired.

FIG. 27 shows illustrative display screen **2700** which may be used to present recommended radio stations to a user. Recommended station list **2790** may be presented to user. If more stations are recommended than will fit onto a single screen, the system may allow the user to scroll or page to view additional selections. Each selection may include information such as broadcast frequency **2710**, call letters **2720**, and station format **2730**. Each selection may also include on-screen buttons **2740** that may be selected by the user to immediately start listening to the station, buttons **2750** to view a schedule of programming on the station, and buttons **2760** to view a play list for the station. Other items may be shown on screen **2700** as well. This screen may be displayed in different formats depending on the characteristics of display device **150** and user controls **140** of FIG. 1.

FIG. 28A shows illustrative process **2800** for recommending local events to a user, and is illustratively discussed in conjunction with FIG. 1. The steps of this process may be performed in any suitable order, and any steps may be omitted if desired. In step **2805**, the system may acquire user information, such as user preferences. Flow chart **2110** of FIG. 22, discussed above, shows an illustrative process for acquiring user preferences. In step **2810**, the system may acquire geographic position information, for



example using global positioning system monitor **160**, or by monitoring which radio stations are available and comparing them with a database of radio stations and geographical regions served by them. In step **2815**, the system may acquire information about local events. Events may include concerts, celebrity appearances, signings, radio station events, contests, etc. Event information may be acquired using communications device **155**. In step **2820**, the system may select one or more recommended events. Events may be selected by comparing information about each event with user information, and selecting events that most closely match user preferences. In step **2825**, the system may present one or more recommended events to the user, for example on display device **150**.

FIG. **28B** shows illustrative process **2850** for recommending local facilities to a user, and is illustratively discussed in conjunction with FIG. **1**. The steps of this process may be performed in any suitable order, and any steps may be omitted if desired. In step **2855**, the system may acquire user information, such as user preferences. Flow chart **2110** of FIG. **22**, discussed above, shows an illustrative process for acquiring user preferences. In step **2860**, the system may acquire geographic position information, for example using global positioning system monitor **160**, or by monitoring which radio stations are available and comparing them with a database of radio stations and geographical regions served by them. In step **2865**, the system may acquire information about local facilities. Facilities may include concert venues, tourist attractions, radio stations, stores, hotels, restaurants, other local businesses, etc. Facility information may be acquired using communications device **155**. In step **2870**, the system may select one or more recommended facilities. Facilities may be selected by comparing information about each facility with user information, and selecting facilities that most closely match user preferences. In step **2875**, the system may present one or more recommended facilities to the user, for example on display device **150**.

FIGs. **29A** and **29B** show illustrative display screens **2900** and **2920** for recommending local events to a user listening to an enhanced radio system in an automobile, and are discussed illustratively in conjunction with FIG. **6A**. Screen **2900** may be shown on display **644** when the user indicates a desire to find local events. The

user may be prompted to press a button, such as SEARCH button 622, to begin the search. In display screen 2920, the first search result may be displayed. The Joe Jackson concert 2922 may be recommended because the user has a preference for that performing artist. The system may also display prompt 2924 to press FAST-FORWARD button 630  
 5 to advance to the next search result, and display prompt 2926 to press LIKE button 638 to view information about the event. Displayed information may include date and time, location, price, where to buy tickets, a phone number to obtain additional information, directions to the concert venue, or other appropriate information. The system may also display a prompt allowing the user to buy one or more tickets interactively. Local facility  
 10 information may be similarly shown on display 644.

FIG. 30 shows flow chart 3000 of a process to provide communication features in an enhanced radio system, and is discussed illustratively in conjunction with FIG. 1. Any steps from this process may be performed in any suitable order if desired. The system may use communications device 155 to provide these features. In step 3005, the system  
 15 may download information about radio stations, such as a radio station database. In step 3010, the system may download a user profile, which may include user preferences and other user information. In step 3015, the system may synchronize data between two enhanced radio systems, for example by copying user preferences, station presets, and other information from one system to the other. In step 3020, the system may access an  
 20 enhanced radio web site to perform functions such as retrieve data, upload data, or present a web page to the user. In step 3025, the system may download information about local events and local facilities. In step 3030, the system may allow a user to respond to radio content, such as automatically telephoning a radio station or advertiser. In step 3035, the system may allow the user to send a message to another enhanced radio  
 25 user. In step 3040, the system may receive a message from another enhanced radio user and present the message to the user. In step 3045, the system may download a software update. In step 3050, the system may allow a user to download a song or other audio content to store in memory 120 and play back later. In step 3055, the system may report usage data to a central facility.

FIG. 31 shows illustrative enhanced radio web page **3100**. A user may be able to access web page **3100** using a web browser running on computer **355**, and it may be displayed on monitor **370** of FIG. 3. Web page **3100** may include link **3105** to view concert information and purchase concert tickets. Link **3110** may allow a user to view information about concert venues. Link **3115** may allow the user to purchase CDs or other music products. Link **3120** may allow the user purchase other products. Link **3125** may allow the user to enter a contest. Link **3130** may allow the user to play a music trivia game. Link **3135** may allow the user to view profiles of performing artists. Link **3140** may allow the user to access a music information database. Link **3145** may allow the user to define his profile, including songs, artists, genres, and radio stations that he likes and doesn't like. Link **3150** may allow the user to access a desktop radio feature, to listen to music on the computer. Link **3155** may allow the user to access a database of radio stations. Link **3160** may allow the user to view schedules of programs on radio stations. Link **3165** may allow the user to synchronize user information and other data with an enhanced radio system. Advertisement **3170** may be targeted based on user preferences and history. These links are merely illustrative. Other links may be provided if desired. Other web page designs are also possible.

FIGs. **32A** and **32B** are block diagrams showing how an enhanced radio system may synchronize data with another enhanced radio system or with an enhanced radio web site. In FIG. **32A**, personal computer **3210** may be connected to portable memory device **440** of FIG. 4. The memory device may be a flash memory card, a smart card, a mobile telephone, a PDA, or other such device. Personal computer **3210** may connect to memory device **440** via any appropriate connection, such as serial port, infrared, universal serial bus (USB), PC Card bus, or any other suitable connection. Information, such as a user profile, station presets, a radio database, radio station schedules, event information, facility information, music information (e.g., audio signatures, information about songs, artists, genres, etc.), or other such information, may be transferred over the connection from personal computer **3210** to portable memory device **440**.

As shown in FIG. **32B**, portable memory device **440** may subsequently connect to an ERS. The connection may be any appropriate connection, such as PC Card bus, serial

port, USB, or infrared. The information previously loaded from personal computer **3210** into memory device **440** may be loaded into an ERS.

If desired, information may be loaded from an ERS to personal computer **3210** using portable memory device **440**. If desired, information may be loaded from one ERS  
5 to another ERS using portable memory device **440**.

FIGs. **33A** through **33C** show illustrative screens that may be shown on display device **150** (FIG. **1**) as part of a two-way response feature. Such a feature may assist a user in responding to radio content, such as a commercial, a contest, a call-in show, a concert promotion, or the like. This feature may use a mobile telephone connected to an  
10 ERS, or other communications device **155** (FIG. **1**). In screen **3310** of FIG. **33A**, the user may be provided a telephone number **3312** to respond to radio content. The user may also be prompted **3314** to press a button to initiate a direct connection. In the case that the user presses the prompted button, the system may automatically dial the telephone (e.g., the mobile phone in the user's car), and make the voice connection through voice  
15 input **648** and car speakers **608** of FIG. **6A**. The radio content may be paused or muted while the connection is in progress.

In screen **3320** of FIG. **33B**, the user may be prompted **3324** to press a button to purchase concert tickets, which may have been promoted on the radio. If the user presses the specified button, the system may transmit the request for tickets to a ticket vending  
20 service, and display the response on display device **150**.

Screen **3330** of FIG. **33C** shows a prompt **3334** for the user to speak a specific command to enter a contest that may have been promoted on the radio. If the user speaks the specified command, the contest entry may be transmitted to the contest facility, and a confirmation may be shown on display device **150**.

25 Flow chart **3400** of FIG. **34** shows a process for providing a radio response feature in an enhanced radio system. If desired, any of the steps of this process may be omitted or performed in any suitable order. In step **3410**, the system may acquire connection information, e.g., information on how to create a communications connection with an external service. The information may include, for example, a phone number, a

web address, or other information needed to create a connection with the external service. In substep 3412, the information may be found in a radio station database. In substep 3414, the information may be acquired from the radio signal. The information may be acquired from a source other than the radio signal, such as communications device 155 (FIG. 1). Alternatively, the information may be hand entered by the user.

In step 3415, the user may be allowed to enter information to allow remote purchasing including payment information, shipping addresses, contact information, and any other information that may be requested or required. This information may be entered offline, for example at a web site or on a personal computer, and loaded into the enhanced radio system. Alternatively, the purchasing information may be entered directly into the enhanced radio system.

In step 3420, the system may initiate a connection with the external service. This may include auto-dialing a telephone in substep 3422, providing a telephone number to the user (e.g., on display device 150 (FIG. 1)) in substep 3426, creating a voice connection (e.g., using voice input 648 and speakers 608 of FIG. 6A) in substep 3424, or creating a data connection in substep 3428. Any of a number of features may be provided over the connection.

In step 3430, the system may allow the user to respond to radio content. In substep 3432, the system may allow the user to respond to a commercial. For example, an offer may be mentioned in the audio of the commercial, and listeners may be invited to call in. The phone number for the advertiser may be broadcast as part of the radio signal and received by the enhanced radio system. The system may auto-dial the advertiser and allow the user to respond to the offer.

In substep 3434, the system may allow the user to respond to a public radio pledge drive. For example, the user may wish to become a listener-member, to make a pledge, or to respond in another way to a pledge drive solicitation.

In substep 3436, the system may allow the user to respond to a contest. For example, a contest may be mentioned on the radio, and listeners may be invited to call in. The phone number to enter the contest may be broadcast as part of the radio signal and

received by the enhanced radio system. The system may auto-dial the radio station and allow the user to enter the contest.

In substep **3438**, the system may allow the user to participate in a call-in show. For example, listeners may be invited to call in to a radio show. The radio station phone  
 5 number may be retrieved from a radio station database. The system may display the phone number for the radio station on display device **150** (FIG. 1). Similarly, the system may allow the user to make a song request to a radio station in step **3440** by auto-dialing the radio station or displaying the radio station phone number for the user.

In substep **3445**, the system may allow the user to make a request. For example,  
 10 the user may indicate a desire to make a song request using user controls **140** (FIG. 1). The system may automatically dial the telephone number for the radio station and make an audio connection between the user and the radio station.

In step **3450**, the user may be allowed to purchase music. This may include buying recorded music in substep **3452** or buying concert tickets in substep **3454**. The  
 15 system may acquire a web address from the radio signal or radio station database, and create a data connection with a web site offering the music for sale. The system may translate input commands from user controls **140** into web commands (e.g., HTTP (Hypertext Transfer Protocol) messages) that may be sent to the web server. Confirmation may be displayed on display device **150**.

20 In step **3460**, the user may be allowed to participate in a live chat. The system may create a voice link by auto-dialing a radio station, and allow the user to participate in the chat using voice input **648** and speakers **608** (FIG. 6A).

While any voice response feature is active, the system may automatically mute or lower the volume of the radio signal. Alternatively, the system may automatically pause  
 25 the incoming radio signal for the duration of the voice interaction.

FIG. 35 shows flow chart **3500** of an illustrative process for allowing the user to send a message to a user of another enhanced radio system. Any suitable subset of these steps may be performed in any suitable order. In step **3505**, the user may be allowed to send an instant message to another user, which the other user may receive and listen to or



view immediately. In step **3510**, the user may be allowed to send an electronic mail message to another user, which the other user may receive and listen to or view at a later time. In step **3515**, the system may create a voice connection between the two users. In any of these cases, the system may allow the user to specify an electronic address or  
 5 name for the other user. The system may also allow the user to maintain a list of other users to make sending messages simpler.

In step **3520**, the user may be allowed to include media with the message. This may include text entered by the user, a music clip, a voice message recorded by the user, or any combination of these and other types of media. In step **3525**, the system may  
 10 allow the media to be content recorded from a radio station by the enhanced radio system. In step **3530**, the system may allow the user to include a link to a song or other content. The link may be a name, a unique identifier, an audio signature, or other types of links or combinations of such links. In step **3535**, the system may allow the user to include a link to a radio station, such as a broadcast frequency or set of call letters. In step **3540**, the  
 15 system may allow the user to include a link to a radio show, which may include a link to the station airing the show and the name or broadcast time of the show. When the other user receives a link to a song, station, show, or other item, the other user's enhanced radio system may allow him or her to easily access that item based on the information sent in the message. In step **3545**, the system may allow the user to include a concert invitation.  
 20 The invitation may include information about the concert automatically filled in by the system. The system may allow the user to purchase a concert ticket or other item for the other user and send a confirmation to the other user. In step **3550**, the system may allow the user to attach any other information related to music or radio. This may include, for example, a web site, the user's rating for a song, information from a database about a  
 25 song, artist, or radio station, or other suitable information.

FIGs. **36A** through **36F** show illustrative display screens for allowing a user to send a message to another user, and are illustratively discussed in conjunction with the embodiment of FIG. **6A**. These display screens may be shown on display **644**. Display screen **3600** of FIG. **36A** may be shown when the user chooses to send a message. It may  
 30 include option **3602** to send an instant message, option **3604** to send an electronic mail

message, and option **3606** to create a voice connection. The user may select an option, for example, by pressing the indicated button on front panel **610** or remote control **676** (FIG. **6C**), or by speaking a command using voice input **648**.

Once the user selects an option from screen **3600**, for example option **3604** for an  
 5 electronic mail message, the system may show display screen **3610** of FIG. **36B**. This screen may include option **3612** for including a song clip with the message. It may include option **3614** for including a song link with the message. It may also include indicator **3616** instructing the user to press FAST-FORWARD button **630** to advance to the next screen.

10 Display screen **3620** of FIG. **36C** may include option **3622** for including a link to the current radio station. It may include option **3624** for including a link to the current radio show. And it may include indicators **3626** and **3628** instructing the user to press REWIND button **626** to return to the previous screen or FAST-FORWARD button **630** to advance to the next screen.

15 Display screen **3630** of FIG. **36D** may show option **3632** for including concert information with the message. It may include option **3634** for including a song web site with the message. Display screen **3640** of FIG. **36E** may include option **3642** for recording a voice segment to include with the message.

Display screen **3650** of FIG. **36F** may include option **3652** allowing the user to  
 20 review the message that has just been created. It may also include option **3654** to allow the user to send the message to the other user.

The display screens and options shown in these figures are merely illustrative. Other display screens and options may be shown.

FIG. **37** shows flow chart **3700** of an illustrative process to collect and report  
 25 enhanced radio usage data. The steps of this process may be performed in any suitable order, and any steps may be omitted if desired. In step **3710**, the system may collect information on radio stations that the user listens to. The information may include information on days and times that stations were listened to. It may also include

information on particular songs, commercials, shows, and other content that the user may have actually heard, as well as indications of content the user may have skipped over.

In step **3720**, the system may collect information on enhanced radio features accessed by the user. For example, the system may log each feature used, and the day  
5 and time the feature was selected.

In step **3730**, the system may combine and filter the information to reduce the total amount of data. The information may be combined and summarized, and information may be filtered out based on the end purpose for the data. Personal data may be removed for privacy reasons. In step **3740**, the information may be sent to a central  
10 facility for analysis, using communications device **155** (FIG. 1).

FIG. **38** shows illustrative flow chart **3800** of a process to provide a karaoke feature, and is discussed illustratively in conjunction with the block diagram of FIG. 1. The steps of this process may be performed in any suitable order, and any steps may be omitted if desired. In step **3810**, the system may receive the vocal portion of the audio  
15 from a radio station separately from the rest of the audio signal. Alternatively, the radio station may transmit information indicating the frequencies used for the vocal portion of the audio. In step **3820**, the system may receive the lyrics for a song. The lyrics may be received as part of the radio signal along with the audio signal for the song.

Alternatively, the system may acquire the lyrics separately using communications device  
20 **155**. In step **3830**, the system may indicate the availability of the karaoke feature to the user when the incoming radio signal supports it, for example on display device **150**. In step **3840**, the system may allow the user to select karaoke mode, for example with user controls **140**. In step **3850**, the system may remove the vocal portion of the audio. It may simply ignore the portion of the incoming signal with the vocal, or it may perform a  
25 filter on the signal to remove the vocal frequencies. Preferably, the vocal should be removed as the audio is read from memory **120**. This will allow the vocal (and lyrics) to be stored in memory, and accessed later. For example, the user may alternately listen to the audio both with and without lyrics. In step **3860**, the lyrics may be displayed, for example on display **644** (FIG. 6A) or monitor **370** (FIG. 3).

FIG. 39 shows flow chart 3900 of an illustrative process for providing an integrated telephone feature, and is discussed illustratively in conjunction with the block diagram of FIG. 6A. The steps of this process may be performed in any suitable order, and any steps may be omitted if desired. In step 3910, the system may allow a telephone  
 5 service to be connected to the enhanced radio system. For example, a mobile telephone may be connected to the system. Alternatively, the system may be connected to a wired telephone line.

In step 3920, the system may allow voice dialing. The user may be allowed to create a list of common telephone numbers. The user may be allowed to dial using a  
 10 voice command using voice input 648. The user may also be allowed to dial using buttons on front panel 610, remote control 676 (FIG. 6C), or other user controls.

In step 3930, the system may accept telephone input from voice input 648. In step 3940, the system may send telephone output to audio output 130 (FIG. 1). The system may also perform signal canceling based on the telephone output to prevent audio  
 15 feedback or echoes. In step 3950, the system may automatically lower the volume of the radio signal or mute the radio signal while a telephone call is in progress. In step 3960, the system may automatically pause the radio signal for the duration of the telephone call.

Other telephone features may also be supported. For example, in step 3970, the system may allow a telephone call to be recorded into memory 120 (FIG. 1). In step  
 20 3980, the system may provide a voice mail feature, using a recorded message from memory 120, and recording the incoming call into memory 120.

FIG. 40 shows a flow chart of an illustrative process for providing an enhanced radio scan feature, and is illustratively discussed in conjunction with the embodiment of FIG. 6A. Any steps of this process may be omitted if desired. In step 4010, the user may  
 25 be allowed to initiate scan mode. For example, the user may press SCAN button 620 on front panel 610 or remote control 676 (FIG. 6C). In step 4020, the system may begin recording one or more stations scheduled to be selected soon. For example, the system may assign five receivers to the scan feature. One receiver may be assigned to the currently selected station, and the other four receivers may be assigned to the four

stations to be selected next. The system may use these four receivers to scan for stations in advance of when they will be played for the user.

In step **4030**, the system may switch to the next radio station. This includes substep **4032** of playing audio from the next station. That may involved simply  
 5 switching from the buffer being used to provide audio to the audio output device to the buffer being used to collect data from the second receiver. In step **4040**, a receiver may be reassigned from an old station to an upcoming station. For example, the receiver being used to receive the most recent station may be used to scan and find the next available station. Alternatively, if the system is configured to record audio from the most  
 10 recently listened radio station, the system may use the receiver that was being used for the second-most recent station.

In step **4050**, the user may be given the opportunity to stop the scan, for example by pressing SCAN button **620** a second time. If the user does not stop the scan, the system may pause a short period of time (e.g., a second or two), and repeat step **4030**,  
 15 scanning to the next station. If the user does stop the scan, the system will not scan to the next station. The user may be given the opportunity to listen to audio that was broadcast prior to when the audio for the final station began playing, in step **4060**. In step **4070**, the system may reassign the receivers and buffers used to provide the scan feature to be used for other purposes. If desired, the system may wait a period of time in case the user  
 20 decides to resume scanning.

If desired, the user may be allowed to scan in either direction (i.e., through higher radio frequencies or lower radio frequencies). The user may also be allowed to scan across multiple radio sources (e.g., both Internet and radio frequency broadcasts).

FIG. **41** shows illustrative memory map **4100** of data stored in memory **120** (FIG. **1**).  
 25 1). Radio input buffers **4105** may be used to store the most recent radio inputs received from one or more radio stations. This area of memory may be assigned dynamically, with different radio stations having buffers of different sizes. A new area of memory may be allocated when a radio receiver is tuned to a new station, and the area may be increased or decreased in size as the user selects or deselects the station or performs other  
 30 functions.

Memory region **4110** may be used for stored songs and other content recorded from the radio or downloaded using communications device **155** (FIG. 1). Memory region **4115** may store information about songs and other audio segments, such as names, identifiers, audio signatures, etc. Memory region **4120** may be used to store information  
5 about different groups of content, such as artists or genres of music. Memory region **4125** may store information about radio stations. Memory region **4130** may store radio station presets. Memory region **4135** may store other user preferences. Memory region **4140** may store automatically collected usage information, such as stations the user has listened to and features the user has accessed. Memory region **4145** may store a user's  
10 contact list for a messaging or telephone feature. Memory region **4150** may be used to store software updates for the system. This memory map is merely illustrative. Other organizations of memory are possible.

Some of the memory may be volatile (subject to loss if the power is lost) and some may be nonvolatile (maintained when the power is lost). It may be desirable to  
15 store some information, such as radio input buffers, in volatile memory, and to store other information, such as user preferences, in nonvolatile memory. If desired, all memory may be nonvolatile.

Although our present invention has been described in considerable detail with reference to certain preferred versions thereof, other embodiments are possible.  
20 Therefore, the spirit and scope of the invention should not be limited to the description of the preferred embodiments contained herein.